Consumers Power Company

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81-03 #13

April 23, 1982

Mr J G Keppler, Regional Administrator
US Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

Mr H R Denton (25)
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, DC 20555

MIDLAND PROJECT -
DOCKET NOS 50-329 AND 50-330
BORATED WATER STORAGE TANK FOUNDATION OL DESIGN CALCULATIONS
FILE: 0485.16, 0.4.9.49 SERIAL: 16172

References: J W Cook letters to J G Keppler:

(1) Serial 11201, dated February 20, 1981
(2) Serial 11528, dated April 3, 1981
(3) Serial 12015, dated June 12, 1981
(4) Serial 12799, dated June 26, 1981
(5) Serial 13352, dated July 21, 1981
(6) Serial 13653, dated August 28, 1981
(7) Serial 14591, dated October 26, 1981
(8) Serial 14339, dated November 13, 1981
(9) Serial 14902, dated November 24, 1981
(10) Serial 14645, dated December 11, 1981
(11) Serial 14664, dated January 18, 1982
(12) Serial 16127, dated March 15, 1982

This letter, as were the referenced letters, is an interim 50.55(e) report concerning the existence of cracks in the borated water storage tank foundation.

Attachment 1 provides a report of the analyses and corrective actions that have been or will be taken as a result of the deficiency identified with these cracks.

Another report, either interim or final, will be sent on or before July 2, 1982.

James W. Cook

APR 29 1982

IE27 5/1 ~~IE19~~

Attachment 1
Serial 16172
81-03 #13

Bechtel Associates Professional Corporation

067174 067259

SUBJECT: MCAR 48 (issued 1/29/81)

The Existence of Cracks in the Borated Water Storage Tank Foundation - Units 1 and 2

FINAL REPORT

DATE: April 20, 1982

PROJECT: Consumers Power Company
Midland Plant Units 1 and 2
Bechtel Job 7220

Introduction

This report addresses the existence of cracks in the borated water storage tank (BWST) foundations as described in MCAR 48 and three subsequent interim reports. This report is a final statement on the investigative analyses and all corrective actions that have been or will be taken as a result of the deficiency identified with these cracks.

Description of Deficiency

The 52-foot diameter, stainless steel BWSTs are 32 feet high and rest on a reinforced concrete ring wall and compacted, granular backfill material contained within the ring wall. On one side is an integral valve pit that houses connections and valves for the two 18-inch diameter pipelines that service each tank. Figure BWST-1 from the Atomic Safety and Licensing Board (ASLB) Hearing Testimony of Alan J. Boos and Dr. Robert Hanson regarding remedial measures for the BWST is attached for reference.

During the load test on the Unit 1 tank (conducted in compliance with the response to 10 CFR 50.54(f), Question 4), a discrepancy was noted between measurements of settlements recorded at the jobsite and the computed displacements derived from the structural analysis used at that time. As a result, the analysis was modified to include a finite-element model of the soil subgrade. A number of analyses were completed using various values for the modulus of elasticity (E) of the soil. The results of the analyses predicted that moments at several locations in the foundation structure exceed allowable moments. The foundation at these locations was examined to verify whether visible signs of high strain in the reinforcement existed. Cracks were found in the structure at those locations indicated by the analysis as having greater than allowable moments. The largest crack measured 0.063 inch. Subsequently, the Unit 2 tank foundation was also examined; similar cracks were found, and the largest crack measured 0.035 inch. The smaller bearing area of the Unit 2 valve pit partially explains why the cracks in the Unit 2 tank foundation are smaller than the cracks in the Unit 1 tank foundation.

Attachment 1: MCAR 48, Final Report, "The Existence of Cracks in the Borated Water Storage Tank Foundation - Units 1 and 2, dated April 20, 1982

CC: RJCook, Midland Resident Inspector
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DSHood, USNRC (2)
RHernan, USNRC
JHarbour, ASLB
JDKane, USNRC
WOtto, US Army Corps of Engineers
WHMarshall
FRinaldi, USNRC
HSingh, US Army Corps of Engineers
MSinclair
BStamiris
SJPoulos, Geotech Eng, Inc

Safety Implications

As shown in Figure BWST-1, the tanks' outside shell is attached to the ring wall foundation by equally spaced anchor bolts that transfer induced forces from the anchor chair. Field observations indicated gaps between the anchor bolt nut and anchor chair in several locations around the periphery of the tank. In other locations, the anchor chairs were deflected, indicating high tensile stress in the bolts. This anchor bolt behavior results from the distortion of the foundation ring which is caused by differential settlement; this agrees with the conclusions of the modified structural analysis. The tension induced in the bolts is similar to the tension induced by a preload phenomenon and does not affect the ability of the bolts to resist design loads. Although the ring wall is cracked, it is capable of providing the necessary anchorage for the anchor bolts to resist tension due to externally applied forces.

The concrete ring wall confines the foundation material which is loaded by the tank; this confinement causes hoop tension in the ring wall. Cracks equal in size to those observed in the ring wall expose the reinforcing steel to the groundwater and atmosphere. If the reinforcing steel carrying the hoop tension were to corrode significantly, the ability of the ring wall to resist the hoop tension would be reduced. Reduction of overall strength of the ring wall, combined with increased displacements (both vertically and laterally) of the ring wall, may occur, causing stress concentrations in the tank near anchor chairs.

Based on the foregoing discussion, it is concluded that the cracking of the ring beam does not create a present safety problem for the tank. However, it could not be conclusively shown that the safety of future plant operations would not have been affected if the deficiency had gone uncorrected. Therefore, the condition was treated as reportable under the provisions of 10 CFR 50.55(e).

Probable Cause

Review of field observations and analytical investigations leads to an understanding of the probable cause. When the tank was loaded, the bearing pressure on the tank area was increased to approximately 2 ksf greater than the valve pit area; however, this 2 ksf differential was not accounted for in the calculation for ring beam reinforcing. As a result, the valve pit restrained the tank foundation from settling uniformly, causing bending at the ring wall/valve pit junction.

Corrective Action

To ensure that the BWSTs function properly in the future under all design conditions, the following actions are being implemented.

1. A portion of the valve pit and its surrounding area has been surcharged. Figure BWST-2 from the ASLB Hearing Testimony of A.J. Boos and Dr. R. Hanson details the surcharge program which was begun October 27, 1981, and completed March 19, 1982.

   The surcharge operation has consolidated the fill beneath the valve pit, thereby reducing the amount of expected residual differential settlement of the foundation structure over the 40-year life of the plant. In addition, by reducing the differential settlement, the surcharging has reduced the ring wall distortion. However, the proposed remedial plan for the ring wall described below will not take credit for this reduced distortion, and, therefore, is conservative.

2. A reinforcing ring beam will be constructed around the existing ring wall. The new ring beam is sized to resist all imposed loading from the tank, including additional future bending induced by the predicted residual differential settlement between the ring wall and the valve pit. Shear connectors transfer the shear force from the existing ring wall to the new ring beam. One end of the shear connectors will be installed in the existing ring wall by drilling and grouting. The other end will be cast in the new ring beam. All cracks in the existing ring wall that exceed 10 mils will be repaired by pressure grouting. The main reinforcing bars in the new ring beam that terminate at the valve pit are anchored in the roof or base slab of the valve pit by grouting them into drilled holes.

   Construction of the new ring beam is scheduled to take place between May 10, 1982, and July 23, 1982.

3. After ring beam construction is complete, the Unit 1 tank (BWST 1T-60) will be releveled. The Unit 2 tank (BWST 2T-60) need not be releved because the ring wall foundation is not severely distorted.

   A detailed procedure has been developed to define a plan of action to relevel BWST 1T-60. This procedure is supported by an analysis which demonstrates that the tank will not be overstressed during this operation. Strain gaging of the tank will be used as a backup to this analysis. A brief summary of the procedure is provided below.

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a. Drain and vent the tank

b. Mount strain gages

c. Attach 12 to 16 electromechanical jacks to the anchor bolt chairs

d. Lift the vessel approximately 3 feet. (All jacks will be controlled from a central control panel and will lift at the same rate and time.)

e. Support tank with cribbing

f. Install Celotex cofferdam around the inner diameter of the ring wall to contain grout placed in Step k below

g. Add and contour oil-impregnated sand

h. Clean the top surface of the ring wall

i. Place stainless steel shims on the original concrete ring wall. Level to a common datum plane approximately 1-1/2 inches above the ring wall. Set shims to the following standard:

   1) 1/8 inch within any 30 feet of circumference

   2) 1/4 inch over total circumference

j. Remove cribbing and lower the tank

k. Add nonshrink grout under the tank bottom to the Celotex cofferdam and allow grout to set

l. Remove strain gages

m. Tighten anchor bolt nuts

This releveling of BWST 1T-60 is scheduled to begin July 19, 1982, and be completed September 17, 1982. At that time, the piping will be reconnected to the tanks, the tanks will be refilled, and by December 17, 1982, the BWSTs will be in conformance with the requirements of the final safety analysis report (FSAR).

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4. After the new ring beam is constructed, two observation pits will be provided for each BWST foundation at the high stress locations. The new ring beams will be monitored monthly for possible cracks under the service condition for 6 months after filling the tanks. At the end of the monitoring period, a report evaluating cracks will be submitted to the NRC. However, if during the monitoring period any cracks are noted to be 30 mils or larger, an engineering evaluation will be conducted to determine whether the tank should be drained.

   BWST foundation settlement will also be monitored as part of the foundation survey. Foundations are surveyed at 60-day intervals during construction and at 90-day intervals for the first year of plant operation. Subsequent survey frequency will be established after evaluating the data taken during the first year of plant operation. As a minimum, the tank foundation would be monitored annually for the next 5 years of operation and at 5-year intervals thereafter.

   The critical areas of each foundation at the transition zone between the ring wall and the valve pit will be monitored using a strain gage system. This system will be monitored at the same frequency as the foundation survey using established acceptance criteria.

   The construction period survey requirements are currently a part of project construction specifications (7220-C-76). The construction period strain gage monitoring requirements will be incorporated into the project construction drawings of the new ring beam (7220-C-1153 and C-1154) by May 21, 1982. The long-term survey and strain gage monitoring requirements will be incorporated in the FSAR technical specifications by January 1, 1983.

Submitted by: D.M. Griffith for TEJ

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Project Engineering Manager

Concurrence by: E. H. Smith
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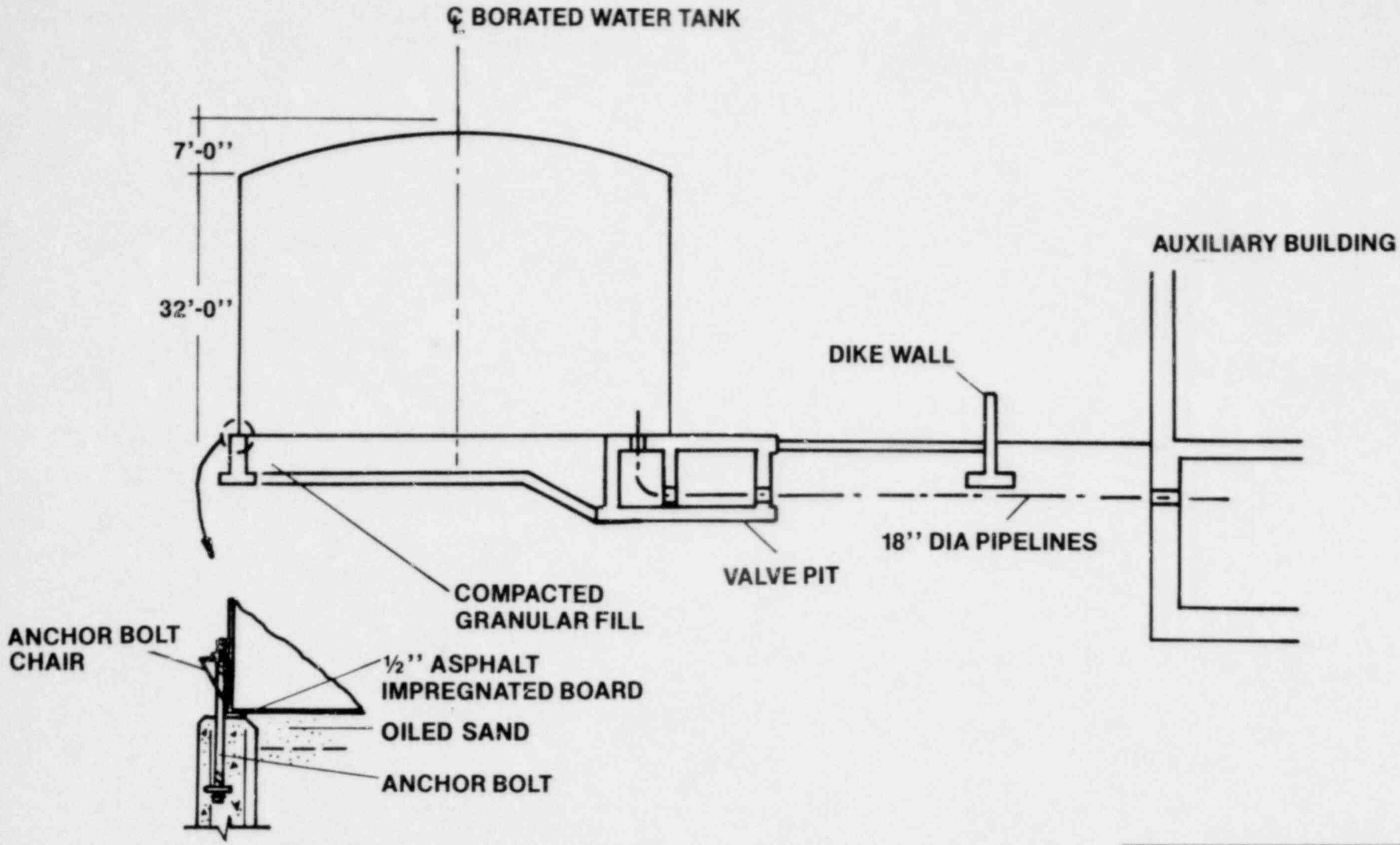

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MIDLAND PLANT UNITS 1 & 2

BORATED WATER STORAGE TANK

FIGURE BWST-1

G-1834-03

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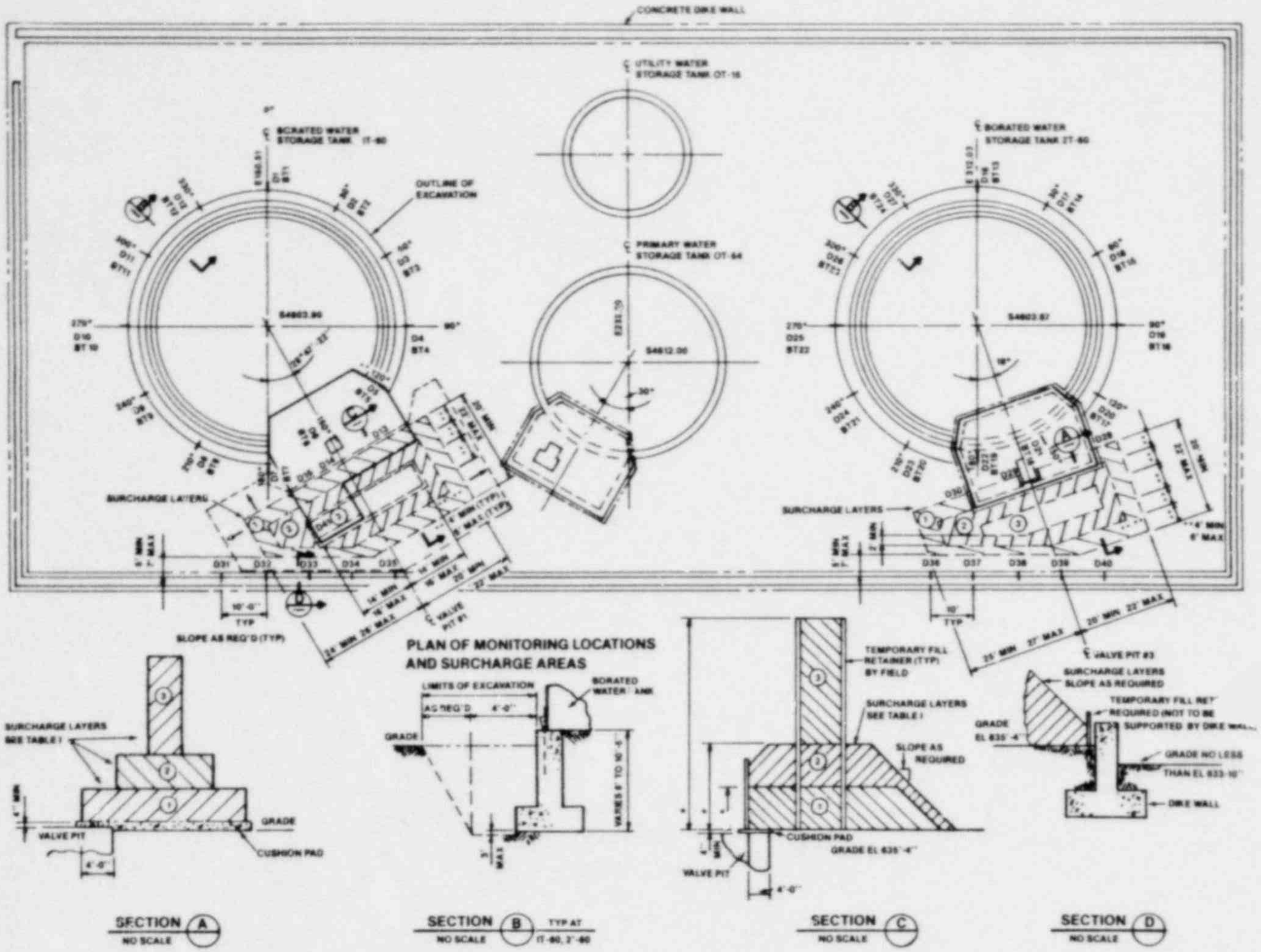

* Granular fill shall be placed to a height such that its weight is equivalent to the weight of the concrete blocks in the corresponding area.

TABLE II
SETTLEMENT MONITORING

DATA BASE NO.	LOCATION 1T-60	ELEVATION (approx)	DATA BASE NO.	LOCATION 2T-60	ELEVATION (approx)
D1	0°	635'-0"	D16	0°	635'-0"
D2	30°	635'-0"	D17	30°	635'-0"
D3	60°	635'-0"	D18	60°	635'-0"
D4	90°	635'-0"	D19	90°	635'-0"
D5	120°	635'-0"	D20	120°	635'-0"
D6	150°	635'-0"	D21	150°	635'-0"
D7	180°	635'-0"	D22	180°	635'-0"
D8	210°	635'-0"	D23	210°	635'-0"
D9	240°	635'-0"	D24	240°	635'-0"
D10	270°	635'-0"	D25	270°	635'-0"
D11	300°	635'-0"	D26	300°	635'-0"
D12	330°	635'-0"	D27	330°	635'-0"
D13	VALVE PIT	630'-0"	D28	VALVE PIT	635'-0"
D14	VALVE PIT	635'-0"	D29	VALVE PIT	635'-0"
D15	VALVE PIT	630'-0"	D30	VALVE PIT	635'-0"
D41	VALVE PIT	629'-4"			
D31	DIKE WALL	637'-4"	D36	DIKE WALL	637'-6"
D32	DIKE WALL	637'-6"	D37	DIKE WALL	637'-6"
D33	DIKE WALL	637'-6"	D38	DIKE WALL	637'-6"
D34	DIKE WALL	637'-6"	D39	DIKE WALL	637'-6"
D35	DIKE WALL	637'-6"	D40	DIKE WALL	637'-6"
BT1	0°	635'-6"	BT13	0°	635'-6"
BT2	30°	635'-6"	BT14	30°	635'-6"
BT3	60°	635'-6"	BT15	60°	635'-6"
BT4	90°	635'-6"	BT16	90°	635'-6"
BT5	120°	635'-6"	BT17	120°	635'-6"
BT6	150°	635'-6"	BT18	150°	635'-6"
BT7	180°	635'-6"	BT19	180°	635'-6"
BT8	210°	635'-6"	BT20	210°	635'-6"
BT9	240°	635'-6"	BT21	240°	635'-6"
BT10	270°	635'-0"	BT22	270°	635'-6"
BT11	300°	635'-6"	BT23	300°	635'-6"
BT12	330°	635'-6"	BT24	330°	635'-6"

TABLE I
SURCHARGE SEQUENCE

STEP	ACTIVITIES	HT OF SURCHARGE SEE NOTE 3	
		1T-60	2T-60
I	1. UTILITY MONITORING SHALL BE COMPLETED 2. CUSHION PAD SHALL BE COMPLETED 3. WATER HEIGHT IN TANK AND ANCHOR BOLT STATUS SHALL BE AS DIRECTED BY PROJECT ENGINEERING	0'-0"	0'-0"
II	1. PLACE SURCHARGE LAYER ① AND HOLD FOR TWO WEEKS	SEE SECTION C	4'-0" MIN 6'-0" MAX
III	1. PLACE SURCHARGE LAYER ② AND HOLD FOR TWO WEEKS	SEE SECTION C	8'-0" MIN 10'-0" MAX
IV	1. PLACE SURCHARGE LAYER ③ AND HOLD FOR SETTLEMENT DATA AS DIRECTED BY PROJECT ENGINEERING	SEE SECTION C	20'-0" MIN 22'-0" MAX
V	1. REMOVE SURCHARGE LAYER ③ AND HOLD FOR TWO WEEKS	SEE SECTION C	10'-0" MIN 12'-0" MAX
VI	1. REMOVE REMAINDER OF SURCHARGE LAYERS ①, ②, AND TAKE REBOUND DATA	0'-0"	0'-0"

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BORATED WATER STORAGE TANKS FOUNDATION SURCHARGE PROGRAM

FIGURE BWST-2

G-1940